

VU Research Portal

Falls in older people

van Dieen, J.H.; Pijnappels, M.A.G.M.

published in

Journal of Electromyography and Kinesiology
2008

DOI (link to publisher)

[10.1016/j.jelekin.2007.06.001](https://doi.org/10.1016/j.jelekin.2007.06.001)

[Link to publication in VU Research Portal](#)

citation for published version (APA)

van Dieen, J. H., & Pijnappels, M. A. G. M. (2008). Falls in older people. *Journal of Electromyography and Kinesiology*, 18(2), 169-171. <https://doi.org/10.1016/j.jelekin.2007.06.001>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl

Editorial

Falls in older people

Falls are common incidents, which can have major consequences. For example, falls and the interrelated category of accidents being struck by or against objects account for more than 40% of injuries and 30% of injury costs in the USA (Corso et al., 2006). Especially among older adults, falls occur frequently (for overview, see Lord and Dayhew, 2001; Masud and Morris, 2001), even in the large group of relatively fit and healthy elderly (Stel et al., 2003). Consequences of falls are known to contribute substantially to the prevalence of health problems (Lord et al., 2001), health care costs (Stevens et al., 2006), and to lost quality of life (Cumming et al., 2000). In the elderly, falls were found to be the second largest source of unintentional fatal injuries and the leading cause of nonfatal injuries (Dellinger and Stevens, 2006). The fact that the population of elderly is rapidly growing in the industrialized world suggests that the scope of this problem can be expected to increase in future decades (Woolf and Pfleger, 2003).

The statistics sketched above show that it is of great importance to prevent falls among the elderly. To develop effective and efficient approaches towards fall prevention in the elderly, causal factors for falls in this group need to be determined. Many epidemiological studies have been published on predictors of falls in the elderly (for overview, see Dieën et al., 2005; Lord et al., 2001; Tideiksaar, 1997). However, given the limitations of such observational designs, these studies often only provide general directions for prevention. Experimental studies can complement data from observational studies with more detailed insight, which can be used to determine who are at risk for falls and which are the modifiable factors determining fall risk.

Fall incidents and the ensuing injury process are multifactorial. Environmental hazards, such as loose carpets and badly visible steps can play a role, but do so usually in combination with intrinsic factors (Tideiksaar, 1997). Stable locomotion and even stable stance depend on adequate cardiovascular function, in particular cerebral blood flow (Carey and Potter, 2001) and adequate proprioception (Bloem et al., 2003). When moving through a variable and unpredictable environment, visual contrast sensitivity and

depth perception are crucial for detection of environmental hazards (Lord, 2006). Moreover, responses need to be selected to deal with these hazards, which requires adequate processing of the information and it has been shown that the level of cognitive functioning affects this (van Schoor et al., 2002). Subsequently, selected responses need to be carried out adequately, which can be limited by neural and muscular factors. When perturbations of balance occur, as they inevitably do, impairments of the sensory system may limit detection. Again adequate response selection and execution may serve to regain balance and prevent a fall. Finally, even when a fall is inevitable, the consequences can be limited by changing the mechanics of the fall and ground contact. Research aspiring to contribute to fall prevention, therefore, needs to be multidisciplinary. The role of epidemiology was already mentioned, but given the above contributions from sensory physiology, muscle physiology, neurophysiology, neuropsychology, and biomechanics are necessary.

This special issue aims to provide an overview of experimental work that attempts to provide a basis for the prevention of falls and fall-related injuries in the elderly. It is based on the presentations of a group of invited participants to a symposium organized as part of the 5th World Congress of Biomechanics held in Munich, Germany in August 2006. Consequently, the focus is on biomechanics, but the importance of neurophysiological and muscle physiological issues and research approaches will be evident in many of the papers presented. Obviously, the format of conference presentations of 10 min is less than ideal for providing a broad overview of the field of study. Where appropriate, the authors were, therefore, invited not to confine themselves to presenting a single study, but rather to provide an overview of their own work in this field. We believe that in this way the issue will provide a valuable introduction for those new to this field and those interested in the broad aspects of experimental research on this topic.

The first paper by Granata and Lockhart focuses on stability of gait. The authors use a numerical method derived from the theory of dynamical systems to quantify stability

of unperturbed steady-state gait in elderly with and without a history of falls. This relatively new approach that was pioneered in the work of [Hurmuzlu and Basdogan \(1994, 1996\)](#) shows promising results for identification of fall-prone elderly.

Hsiao presents a review of work using the so-called tether-release method, which is used to simulate a forward fall by releasing a subject who is initially held in a static inclined position by means of a horizontal tether. The tether-release method is intended to simulate a forward fall, such as would occur after tripping, and has been used to pinpoint biomechanical parameters that determine the ability to recover balance. The literature has mainly focused on the step taken after release to change the base of support in order to regain balance. Results indicate that neuromuscular capacities that relate to lower extremity flexibility, reaction time, and strength are all important for balance recovery.

The paper by Pijnappels et al. further explores this type of falls by an overview on balance recovery after tripping in relation to muscle strength. These authors have mainly focused on balance recovery reactions that occur prior to the change in base of support brought about by placing a leg forward over the obstacle that induced the trip. The stance leg during this phase can already brake the forward fall and it is shown that leg muscle strength is a determinant of the capability to recover balance. In addition, pilot data are presented that indicate that resistance training in elderly might improve this ability.

In addition to trips, slips constitute a major cause of falls ([Berg et al., 1997](#)). Grabiner et al. review the importance of control over the trunk segment in both types of gait perturbations. They conclude that for both trips and slips, the ability to limit trunk motion discriminated between older adults who fell and who were able to avoid falling. Furthermore, older adults were shown to be able to rapidly acquire or learn the ability to limit trunk motion through task-specific training. This suggests that, task-specific training can synergize with resistance training to reduce falls and fall-related injury in older adults.

Lockhart further addresses falls due to slips and shows that a biomechanical approach can identify modifiable risk factors in several stages of the chain of events leading up to an injury. Interestingly, age appears to affect all of these stages. Changes in gait mechanics with age affect the friction required for stable gait, but also the visual detection of a slippery surface and the selection of the appropriate adjustments in gait to this surface appear to take longer in the elderly. Finally, recovery responses after a slip are less effective in the elderly than in young adults.

While falls during level gait may be more prevalent, falls occurring during stair negotiation can have dramatic consequences ([Berg et al., 1997](#)), with 10% of fall-related deaths reported to occur on stairs ([Startzell et al., 2000](#)). Up to date, few studies have addressed stair negotiation by the elderly. Reeves et al. present result suggesting that stair descent requires close to maximum moments to be

produced by the calf muscles. The lower capacity of the elderly then forces them to use a different strategy shifting load from the ankle to the knee, which may have adverse consequences for balance control.

Once a fall occurs, different fall techniques, often derived from martial arts, may affect the outcome. Only in recent years, have several authors started to address this issue ([Robinovitch et al., 2000](#)). The paper by Groen et al. provides a concise review of such studies, but also shows that the commonly made assumption in these studies that velocity at impact predicts impact force can cause considerable errors.

The issue of injury prevention through training in martial arts techniques is further addressed in the paper by Weerdesteyn et al. It is shown that, after a single short training session, substantial reductions in impact force can be achieved by young adults. This type of training has already been integrated in programs for the prevention of fall-related injuries in the elderly ([Weerdesteyn et al., 2006](#)), showing that such an approach is feasible even for elderly people. However, the effect of this training in this group remains to be investigated.

Finally, Maki et al. provide an overview of their work on interventions aimed at fall prevention. The interventions studied have in common that they focus on bringing about an effective change in the base of support to prevent a fall. Encouraging results in terms of short-term effects on balance recovery were obtained of training by means of support perturbations, of footwear that enhances feedback when approaching the boundary of the base of support, of the redesign of a walker to allow a lateral step in case of a sideways perturbation and of cueing for handrail use to expand the base of support.

All together, these papers provide information ranging from fundamental aspects of age-related changes in balance control during locomotion, up to the effects of interventions ready to be applied. The work compiled here in this sense is in our view a good example of what is called ‘translational research’, which aims to bridge the gap between basic research and real-life application. We hope that this special issue will provide a valuable introduction and will challenge and inspire researchers to contribute to this important field.

Shortly after this special issue was completed, Dr. Kevin Granata was killed in the tragic events at Virginia Tech on April 16th 2007. Dr. Granata was an outstanding scientist who made important contributions to the field of biomechanics. While he is probably most known for his work on spine biomechanics especially on stability of the human spine, he more recently expanded his research to stability in relation to human movement in general. The paper in this special issue illustrates some of what he had achieved and gives us a glance of how much more he would have been able to achieve in this area. For those of us who had come to know him, Kevin was a great colleague, a very friendly and supportive person, whom we will dearly miss.

References

- Berg et al., 1997 Berg WP, Alessio HM, Mills EM, Tong C. Circumstances and consequences of falls in independent community-dwelling older adults. *Age Ageing* 1997;26(4):261–8.
- Bloem et al., 2003 Bloem BR, Steijns JA, Smits-Engelsman BC. An update on falls. *Curr Opin Neurol* 2003;16(1):15–26.
- Carey and Potter, 2001 Carey BJ, Potter JF. Cardiovascular causes of falls. *Age Ageing* 2001;30(Suppl. 4):19–24.
- Corso et al., 2006 Corso P, Finkelstein E, Miller T, Fiebelkorn I, Zaloshnja E. Incidence and lifetime costs of injuries in the United States. *Inj Prev* 2006;12(4):212–8.
- Cumming et al., 2000 Cumming RG, Salkeld G, Thomas M, Szonyi G. Prospective study of the impact of fear of falling on activities of daily living, SF-36 scores, and nursing home admission. *J Gerontol A-Biol* 2000;55(5):M299–305.
- Dellinger and Stevens, 2006 Dellinger AM, Stevens JA. The injury problem among older adults: mortality, morbidity and costs. *J Safety Res* 2006;37(5):519.
- Dieën et al., 2005 Dieën JHv, Pijnappels M, Bobbert MF. Age-related intrinsic limitations in preventing a trip and regaining balance after a trip. *Safety Sci* 2005;43:437–53.
- Hurmuzlu and Basdogan, 1994 Hurmuzlu Y, Basdogan C. On the measurement of dynamic stability of human locomotion. *J Biomech Eng* 1994;116(1):30–6.
- Hurmuzlu et al., 1996 Hurmuzlu Y, Basdogan C, Stoianovici D. Kinematics and dynamic stability of the locomotion of post-polio patients. *J Biomech Eng* 1996;118(3):405–11.
- Lord and Dayhew, 2001 Lord SR, Dayhew J. Visual risk factors for falls in older people. *J Am Geriatr Soc* 2001;49(5):508–15.
- Lord et al., 2001 Lord SR, Sherrington C, Menz HB. Falls in older people. Risk factors and strategies for prevention. Cambridge (UK): Cambridge University Press; 2001.
- Lord, 2006 Lord SR. Visual risk factors for falls in older people. *Age Ageing* 2006;35(Suppl. 2):ii42–ii45.
- Masud and Morris, 2001 Masud T, Morris RO. Epidemiology of falls. *Age Ageing* 2001;30(Suppl. 4):3–7.
- Robinovitch et al., 2000 Robinovitch SN, Hsiao ET, Sandler R, Cortez J, Liu Q, Paiement GD. Prevention of falls and fall-related fractures through biomechanics. *Exercise Sport Sci R* 2000;28(2):74–9.
- Startzell et al., 2000 Startzell JK, Owens DA, Mulfinger LM, Cavanagh PR. Stair negotiation in older people: a review. *J Am Geriatr Soc* 2000;48(5):567–80.
- Stel et al., 2003 Stel VS, Smit JH, Pluijm SM, Lips P. Balance and mobility performance as treatable risk factors for recurrent falling in older persons. *J Clin Epidemiol* 2003;56:659–68.
- Stevens et al., 2006 Stevens JA, Corso PS, Finkelstein EA, Miller TR. The costs of fatal and non-fatal falls among older adults. *Inj Prev* 2006;12(5):290–5.
- Tideiksaar, 1997 Tideiksaar R. Falling in old age. New York: Springer; 1997.
- van Schoor et al., 2002 van Schoor NM, Smit JH, Pluijm SMF, Jonker C, Lips P. Different cognitive functions in relation to falls among older persons: immediate memory as an independent risk factor for falls. *J Clin Epidemiol* 2002;55(9):855.
- Weerdesteyn et al., 2006 Weerdesteyn V, Rijken H, Geurts AC, Smits-Engelsman BC, Mulder T, Duysens J. A five-week exercise program can reduce falls and improve obstacle avoidance in the elderly. *Gerontology* 2006;52(3):131–41.
- Woolf and Pfleger, 2003 Woolf AD, Pfleger B. Burden of major musculoskeletal conditions. *B World Health Organ* 2003;81(9):646–56.

Jaap H. van Dieën
Mirjam Pijnappels

*Institute for Fundamental and Clinical Human Movement
Sciences, Faculty of Human Movement Sciences,
Vrije Universiteit Amsterdam, The Netherlands
Tel.: +31 20 5988501; fax: +31 20 5988529.
E-mail address: j.vandieen@fbw.vu.nl (Jaap H. van Dieën).*